Sample: CDS130 Final exam (PART I)

The final exam consists of two sections. The first section is a closed-book paper exam (60 minutes); and the second section involves use of Matlab on the computer (75 minutes). The following part is the first section of the exam.

- Be sure your exam booklet has 8 pages for this section.
- Write your name at the top of each page.
- This is a closed book exam.
- All computational commands and statements appearing in this exam are specifically referring to the Matlab programming language taught in class.
- You may not use Matlab on the computer during this section.
- Absolutely no interaction between students is allowed.
- Each question is worth 5 points. Partial credit may be awarded ONLY if work is shown.
- The exam will take place in IN 326.
- Duration for this section: 60 minutes (10:30am – 11:30am).

Q1. Suppose x is a new variable, with the following Matlab statement,

```
x = [-10: -1: -15; -2: 3];
```

How many elements are generated in x?

(A) 0; because there is an error in the assignment
(B) 10
(C) 12
(D) 5
(E) 6

Answer: B

$$x = \begin{pmatrix} -10 & -11 & -12 & -13 & -14 & -15 \\ -2 & -1 & 0 & 1 & 2 & 3 \end{pmatrix}$$

Q2. A matrix was generated using

```
M = rand(10);
```

Which of the following statements is **not** valid in Matlab?
(A) M+M*2
(B) M(1, :)^2
(C) sin(M)
(D) exp(M)
(E) M(10,10)+M(3,6)

Answer: B

M = rand(10); % This creates a 10x10 matrix.
M(1, :) accesses the first row of the matrix, and this corresponds to a vector.
If M(1, :) is a vector, a dot operator should be used for its power series, such as:
M(1, :).^2

Q3. What is the output of executing the following Matlab code?

```
clear;
for i=1:5
   for j=i:5
    M(i, j) = i+j;
    M(j, i)= M(i,j);
   end
end
M(4, 3)
```

Answer: M(4,3) =

7

The double nested for loops create a symmetric 5x5 matrix:

$$M = \begin{pmatrix} 2 & 3 & 4 & 5 & 6 \\ 3 & 4 & 5 & 6 & 7 \\ 4 & 5 & 6 & 7 & 8 \\ 5 & 6 & 7 & 8 & 9 \\ 6 & 7 & 8 & 9 & 10 \end{pmatrix}$$

M(4,3): element at the forth row and the third column of the matrix.

Q4. In order to print formatted integers with the following format,

00005

00006

00007
00008
00009
00010

which fprintf statement should be used in the following code?

```
for i=5:10
   fprintf(          )
end
```

(A) fprintf('%5.5f\n', i)
(B) fprintf('%5.2d\n', i)
(C) fprintf('%05d', i)
(D) fprintf('%5.5d\n', i)
(E) fprintf('%d\n', i)

Answer: D

Explanation:
(A) fprintf('%5.5f'\n', i) prints floating-point numbers, with 5 digits after the decimal point.

5.00000
6.00000
7.00000
8.00000
9.00000
10.00000

BTW, fprintf('%10.5f'\n', i) prints the following numbers:
5.00000
6.00000
7.00000
8.00000
9.00000
10.00000
The width of the number has 10 digits, with 5 digits after the decimal point.
__10.00000

(B) fprintf('%5.2d\n', i) prints
05
06
07
08
09
10

(C) fprintf('%05d', i)
'\n' puts a new line after each number. Without '\n', this looks like:
000050000600007000080000900010

fprintf('%05d\n',i) prints
00005
00006
00007
00008
00009
00010

(D) fprintf('%5.5d\n', i)

This is the correct answer. 5 digits are reserved for the integer i (the width); and 5 digits are printed (such as 00005, 00006...) to represent the integer (precision).

(E) fprintf('%d\n', i) prints unformatted integers

5
6
7
8
9
10

Q5. Involving fprintf and nested for-loop commands, write a Matlab script to print the following pattern:

1
12
123
1234
123456
1234567

Answer:

```
for i=1:7                  %  7 rows altogether
    for j= 1:i             % this is important  to set the length of each row.
        fprintf('%d', j)   %  print the numbers on each row, number-by-number
    end
    fprintf('\n')          % start from a new line.
end
```

Q6. Given the following Matlab code,

```
k= 0;
while  k ^0.5 < k
     k = k + 1;
end
k
```

what is the value of k after executing the code ?

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4

Answer: 0
k =0;
the while statement 0^0.5 < 0 is false, so the while-loop is not executed, and the value of k is not updated.

k= 0

Q7. Using one if-statement to rewrite the following nested if-statement

```
if w < x
  if  w > y
      w = x*y
  end if
end if
```

Answer:

```
if w<x & w>y
    w = x*y
end
```

Q8. Using nested for-loops to generate a matrix that has elements shown below (without typing the numbers explicitly):

$$A=\begin{pmatrix} 12 & 8 & 4 & 0 & -4 \\ 14 & 10 & 6 & 2 & -2 \\ 16 & 12 & 8 & 4 & 0 \end{pmatrix}$$

Answer:

One solution from the students

```
for i=1:3
    if i==1
      A(1, :) = 12:-4:-4;
    elseif i==2                    % IMPORTANT: elseif is different from else if.
      A(2, :) = 14:-4:-2;
    elseif i==3
       A(3, :) = 16:-4:0
    end
end
```

This is probably acceptable. However, according to the question, nested for-loops are required.

My solution:

```
for i=1:3
   for j =1:5
      A(i,j) = 14+2*i – 4*j
   end
end
```

The difference lies in different “algorithmic” thinking.

Q9. Given vectors x=[-1, 2, 3, -2], y=[0.2, 3.1, 0, -3] and z=[3, 0, 1, 0.1], provide answers to the following operations

(A) x < y > z
Answer: [0 1 0 0]

(B) x + ~y > z
Answer: [0 1 1 0]

(C) x == y ~=z
Answer [1 0 1 1]

Explanation:
(A) x< y > z

(1) This problem concerns "Relational operators". The outcome of the relational operators is always "true" and "false", i.e., 0's and 1's.

(2) Evaluate the expression from left to right, e.g.,
x<y>z

x<y yields [1 1 0 0], which will be compared with z.
[1 1 0 0] > z has
[0 1 0 0]

(B) x + ~y > z
We always evaluate the NOT operator (this is the correct order of precedence).
~y :
[0 0 1 0]

x+~y:
[-1 2 4 -2]

x+~y > z :
[0 1 1 0]

(C) x == y ~=z
x == y :
[0 0 0 0]

[0 0 0 0] ~= z :
[1 0 1 1]

Q10. Images in Matlab are represented by matrices. In order to properly display the image with desired colors, a color map is needed (for indexed images). Given a matrix

$$M = \begin{pmatrix} 0.1 & 0.5 & 0.7 \\ 0.9 & 0.4 & 0.6 \\ 0.5 & 0.8 & 0.2 \end{pmatrix}$$

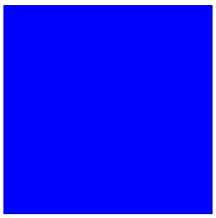
with the following Matlab code:

```
M=[0.1, 0.5, 0.7; 0.9, 0.4, 0.6; 0.5, 0.8, 0.2];
colormap(M);
imagesc(~(M>0.5))
axis square off
```

Which of the following statements is most likely correct?

(A) No image will be produced, because the colormap is not properly assigned.

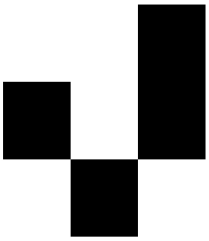
(B) The following image will be produced:



(C) The following 3-color image will be produced:

(D)The following 2-color image will be produced:

(E) The following white and black image will be produced:



Answer: _____

(1) A matrix was created, but it was transformed in
imagesc(~(M>0.5))

M>0.5 % this is a relational operator. A new matrix is generated as a result of the operation: all the elements that have values greater than 0.5 will become "1".

M>0.5 :

$$\begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

~(M>0.5) :

$$\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{pmatrix}$$

(2) a color map was created and it has three colors. (The colormap matrix share the same value as the image matrix).
The color map has the following color s
[0.1, 0.5, 0.7];
[0.9, 0.4, 0.6];
[0.5, 0.8, 0.2];

Note: The exact color is not important in this problem.

(3) Display the image:

Since where are only two numbers in the transformed image matrix ~(M>0.5), the final image is going to have only two colors, which are not black and white according to the color map.

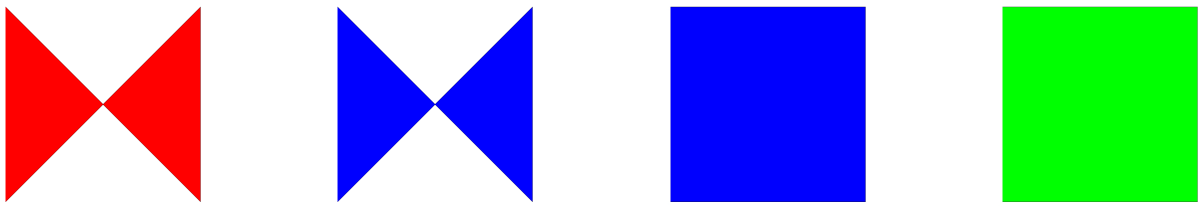
Therefore, the correct answer is:

D.

Q11. The 'fill' command can be used to plot polygons with filled colors. Which plot will be generated by executing the following command lines?

```
clear;
fill([0, 1, 1, 0], [1,1, 0, 0], [0,0,1]);
axis square off;
```

(A) (B) (C) (D)



Answer: C.

The syntax for "fill":

fill (x, y, color).

Here, fill([0, 1, 1, 0], [1,1, 0, 0], [0,0,1]);
the (x,y) coordinates for the first point is:
x=0, y=1
the second point
x =1, y=1
the third point
x= 1, y= 0
the forth point
x = 0, y = 0

Draw this figure in a quadrant, one can easily tell this is a square filled with the blue color.
The correct answer is: (C)

If the problem statement is changed to
fill([0, 1, 1, 0], [0, 1, 0,1], [0, 0, 1]), the correct answer would have been (B).

Q12. Write a Matlab code to calculate the following summation:

$$3*(2+1)+4*(3+2+1)+5*(4+3+2+1)+6*(5+4+...+1)+....+1000*(999+...+1)$$

Using nested for loops:

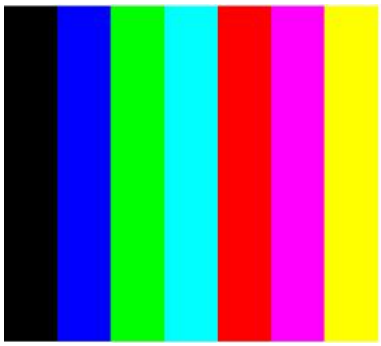
```
sum = 0;

for i=3:1000
   sum1 = 0;
    for j = 1: i-1
        sum1 = sum1 + j;
    end
        sum = sum + i*sum1;
end
sum
```

Sample: CDS130 Final exam (PART II)

The final exam consists of two sections. The first section is a closed-book paper exam (60 minutes); and the second section involves use of Matlab on the computer (75 minutes). The following part is the section section of the exam.

- You are required to use Matlab to solve the problems.
- Absolutely no interaction between students is allowed.
- Partial credit may be awarded ONLY if work is shown.
- Turn in your Matlab code and final answer to each question by email or in paper form.
- Duration for this section: 70 minutes (11:30am – 12:45am).

1. (15 points) Write a Matlab script to create an image as follows:



Solution 1:

```
clear; clc;

x = [0, 0, 1, 1];
y = [0, 8, 8, 0];

color =[0, 0, 0;
        0, 0, 1;
        0, 1, 0;
        1, 1, 0;
        1, 0, 0;
        1, 0, 1;
        0, 1, 1; ]
```

```
hold on;

for i=1:7

    fill(x+i, y, color(i, :));

end

axis square off
```

Solution 2:

```
clear;
for i=1:8
   for j =1:7
      M(i, j) = j;
   end
end
color =[0, 0, 0;
          0, 0, 1;
          0, 1, 0;
          1, 1, 0;
          1, 0, 0;
          1, 0, 1;
          0, 1, 1; ]

colormap(color);
imagesc (M)
```

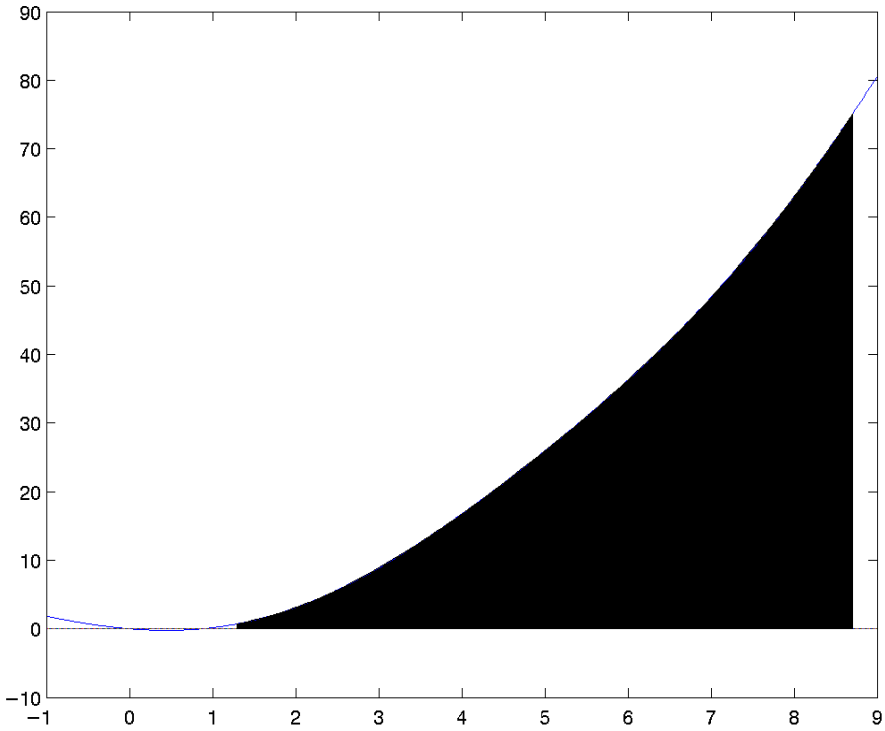
2. (10 points) Given a mathematical function $f(x)=x^2-\sin(x)$, calculate the area underneath the curve from x=1.3 to x = 8.7.

Solution I:

```
clear;
clc;

xlow = 1.3;
xhi = 8.7;

dx = (xhi - xlow)/100;
area = 0;
for x = xlow:dx:xhi
  y = x.^2 – sin(x);
  area = area + y*dx
end

fprintf('The area between %f and %f underneath the curve is %f\n', xlow, xhi, area);
```

Solution 2: (A more complete version, just for your reference)

```
---
clear;
clc;

xlow = 1.3;
xhi =  8.7;
x = linspace(xlow,xhi,100);
y= x.^2 - sin(x);
area = cumsum(y);
fprintf('The area between %f and %f underneath the curve is %f\n', xlow, xhi, area(100));
X = linspace(-2,9,1000);
Y = X.^2 - sin(X)
plot(X,Y, x, y, X, 0)
hold on
fill ( [x(1), x, x(100)],[0, y, 0], 'k');
print -dpng problem2.png
```


90
80
70
60
50
40
30
20
10
0
−10
−1
0
1
2
3
4
5
6
7
8
9

(3) (15 points) You won $100 and want to invest it. Which bank offers the better deal?

Bank A: 12% interest per year compounded yearly

Bank B: 1% interest per month compounded monthly

Bank C: (10/365.2425)% interest compounded daily

"Compounded yearly/monthly/daily" means that at the end of one year/month/day the interest is added to your balance.

Solution:

```
clear; clc;

P_initial = 100;        %initial balance

rate_a = 0.12           % bank A, 12% per year
rate_b = 0.01           % bank B, 1% per month, 12 months in one year.
rate_c  = 0.1/365.2425;

P(1) = P_initial;

% my year-end money from bank A:

for i=1:1
    P(i+1) = P(i) + P(i)*rate_a;
end

P_final_a = P(2);

%my year_end money from bank B:

for i=1:12
    P(i+1) = P(i) + P(i)*rate_b;
end

P_final_b = P(13);

 %my year_end money from bank B:
```

```
for i=1:365
    P(i+1) = P(i) + P(i)*rate_c;
end

P_final_c = P(366);

%Find the bank that offers the best deal:

fprintf('My year-end money form Bank A is  %10.5f\n', P_final_a);
fprintf('My year-end money form Bank B is  %10.5f\n', P_final_b);
fprintf('My year-end money form Bank C is  %10.5f\n', P_final_c);

if (P_final_a > P_final_b & P_final_a > P_final_c)
     fprintf('\n Bank A offers the best deal\n');
elseif (P_final_b > P_final_c & P_final_b > P_final_c)
      fprintf('\n Bank B offers the best deal\n');
else
   fprintf('\n Bank C offers the best deal\n');
end
```